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Assessment of the 1985 4WX herring fishery

by

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ABSTRACT

The 1985 herring fishery in NAFO Div. 4WX was similar to that in previous years. The major portion of the fishery took place off southwest Nova Scotia (June-October; purse seine and gillnet) with smaller concentrations of effort off southern New Brunswick (June-January; weir and purse seine) and off Cape Breton (November-February; purse seine). Total landings for the fishery were 141,860 t, of which 112,385 t were attributed to the 4WX stock.

The fishery continued to be influenced strongly by markets and the year was marked by an even larger roe market (>50% of stock catch) than in 1984.

A revised purse seine log format increased monitoring, and better reporting contributed to a significant improvement in the amount and quality of fishery information on which to base the assessment. In contrast to 1984, it was considered unnecessary to adjust catch statistics for 1985.

Cohort analysis was calibrated, as in previous years, with larval abundance from the autumn Bay of Fundy larval herring survey. Analysis indicated an increase in stock biomass over recent years.

RÉSUMÉ

En 1985, dans la Division 4WX des zones de pêche de l'OPANO, les pêches du hareng ont donné des résultats semblables à ceux des années précédentes. La majeure partie des activités de pêche se sont déroulées au large du littoral sud-ouest de la Nouvelle-Ecosse (juin-octobre; senne coulissante et filet maillant) avec une concentration plus réduite des efforts au large des côtes sud du Nouveau-Brunswick (juin-janvier; pêche à fascines et à la senne coulissante) et au large des côtes du Cap-Breton (novembre-février; senne coulissante). Le total des débarquements de poisson s'est élevé à 141 860 t, dont 112 385 ont été attribuées au stock existant dans 4WX.

Les pêches ont continué à être fortement influencées par les marchés, et l'année a été caractérisée par un marché encore plus vaste de la rogue (> 50 % des prises prélevées dans le stock) qu'en 1984.

En révisant le format des journaux de bord de pêche à la senne coulissante, et en améliorant la façon de rédiger les rapports, on a nettement amélioré la quantité et la qualité de l'information sur les pêches, en fonction de laquelle on doit établir les évaluations. Contrairement à 1984, on n'a pas considéré comme nécessaire d'ajuster les statistiques relatives aux prises de 1985.

On a étalonné l'analyse des cohortes, comme les années précédentes, en tenant compte de l'abondance larvaire telle qu'établie dans le relevé d'autome des larves de hareng dans la baie de Fundy. L'analyse a indiqué une augmentation de la biomasse des stocks depuis quelques années.

INTRODUCTION

The 1985 herring fishery in NAFO Div. 4WX was similar to that in previous years. Purse seine was the major gear type, followed in importance by weirs, gillnet, traps, shutoffs and midwater trawl (Table 1). The major portion of the fishery took place off southwest Nova Scotia (4Xa; June-October) with smaller concentrations of effort off southern New Brunswick (4Xb; June-January) and off Cape Breton (4W Chedabucto Bay; November-February) (Fig. 1, 2).

The fishery continued to be influenced strongly by markets (Table 2) and the year was marked by an even larger roe market (>50% of stock catch) than in 1984 (35-50%).

1985 Management Plan

The Scotia-Fundy Region 1985 Herring Management Plan (Appendix 1) established a quota of 100,000 t for the purse seine fleet, allocated among temporal components of the fishery in the traditional manner (Chedabucto Bay (4W, 4X) summer and winter). Inshore gear components of the summer fishery (gillnets, NS weirs and traps) were allocated 25,000 t for an overall TAC of 125,000 t. The TAC exceeded biological advice but was linked to a system of increased monitoring and reporting of catch in the purse seine segment in order to curb, or at least to monitor, misreporting (see previous assessment, Stephenson et al. 1985). The inshore gear allocation was recognized as being well above the market capacity for that segment, and was set to conform to the traditional 80% purse seine/20% inshore gear breakdown. As in previous years, the N.B. weir and shutoff fishery and a portion (50%) of the fall 4X purse seine fishery (around Grand Manan) were considered to be on non-stock fish (i.e. from the Gulf of Maine stock), and therefore not included in the quota.

Description of the Fishery

4Wa (Chedabucto Bay, Winter) Purse Seine Fishery

In accordance with the 1985 Management Plan, this fishery was open from November 15, 1984 to March 1, 1985, with a quota of 16,000 t. The reported catch of 8751 t was considerably lower than the quota, probably as a result of limited markets, individuals saving quota for the summer fishery, distribution of fish (inside the Chedabucto Bay closure line) and weather. An acoustic survey of the area (Buerkle 1986) showed a large and persistent group of fish in the general area.

4Xb (Bay of Fundy) Fall and Winter Purse Seine Fishery

The Bay of Fundy "fall" and "brit" fisheries were open from October 16, 1984 to March 31, 1985. A total of 9000 t was assigned in two segments: 8000 t before December 31 and 1000 t for the traditional "brit" fishery after January 1. Only 50% of the landings in the October-December segment was applied to the quota. The amount recorded was 5419 t, approximately the same as in 1984, but lower than the landings (10,000-40,000 t) between 1965 and 1975 (Fig. 3).

4Xa (Southwest Nova Scotia) Summer Fishery

a) Purse seine

The 1985 Management Plan limited this fishery to the period June 1 to October 14, 1985 with a quota of 100,000 t, minus what had been taken in the 4W and 4X fall and winter fisheries. Nominal landings of 87,167 t were recorded, the highest since 1968.

b) Gillnet

The gillnet segment of this fishery took 5584 t, an increase of almost 25% over 1984. Once again, the fishery was hampered by a lack of shore-based market and relied on a foreign over-the-side sale program.

c) Weirs

Nova Scotia weirs recorded 4062 t, a substantial increase (~50%) in catch over 1984. Some of the increase may have been due to favorable market conditions, especially early in the season.

4Xb (New Brunswick) Weir and Shutoff Fishery

The New Brunswick weir and shutoff fishery recorded 27,863 t. This is about three times the 1984 catch, and ends a string of record-setting poor years (1979-84).

Catch Statistics

Reported landings for the 1984 fishery (DFO, Scotia-Fundy Region, Statistics Branch records) are listed by month and gear segment in Table 3. Long-term trends in landings by the major gear segments are shown in Table 4 and Fig. 3. Recorded landings for the stock were 112,385 t, the highest since 1977.

Trends in reported stock (attributable to 4WX) and total (nominal) landings and in TAC are as follows ('000 t):

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
TAC	-	-	-	-	109.0	110.0	99.0[1]	65.0[2]	100.0	80.2	82.0	80.0	125.0
Reported stock catch (t)	122.7	149.7	143.9	115.2	117.1	95.9	59.0	79.6	87.7	84.7	84.4	78.1	112.4
Reported total catch (t)	142.6	170.3	174.7	143.9	150.7	134.7	96.2	93.1	106.8	110.7	94.1	88.7	141.9

[1] $F_{0.1}$ yield estimated at 60.0 t.
[2] TAC raised from 60.0 t to 65.0 t in mid-season.

Logbook Information

A new logbook design combined with better reporting and monitoring resulted in an improvement in logbook information. Coverage was 96% of catch (Table 5) as logbook submission was a condition of the fragmented license scheme, and logs were generally complete. The new log format and results of the first season of use are dealt with in detail by Power and Stephenson (1986) and summarized below.

The average trip was 12.2 h, involved 4.3 h of searching and resulted in 1.4 sets. Ninety-six percent of the sets were attributed to 10' squares, most from comments describing location of a Loran C bearing. The average total catch was 40.1 mt, and kept catch 39.5 mt per set. The summary of market codes showed the dominance of the roe fishery; 27% of all logs specified the roe market and an additional 35% indicated "adult shore" which would include roe processing. Release comments were associated with 21% of sets with size of fish (usually too small) given as the primary reason.

Plots of the distribution of catch and effort by 10' square show the focus of fishing activity on major spawning grounds, especially Trinity Ledge, German Bank and the Seal Island area. Two 10' squares covering the Trinity grounds alone account for 41% of all searching and 45% of all sets.

The logs allowed calculation of a number of CPUE measures (including catch per night, catch per hour searching, catch per set and sets per hour searching) with summaries weighted by month, fishing grounds and 10' square number. The variability of these data suggest the need for appropriate stratification to best obtain a fishery CPUE time series which could be developed for the 4Xa purse seine fleet.

Research Surveys

(i) Acoustic survey

An acoustic survey of overwintering herring in Chedabucto Bay, N.S. was undertaken by Buerkle (1986) during Jan. 24-Feb. 2. The survey followed the same search strategy as in 1983 and 1984 and showed a large aggregation in a similar position to previous years. The biomass of the aggregation is estimated to be 214,000 t, about 68% of that estimated from the 1984 survey.

(ii) Experimental offshore (Scotian Shelf) fishery

A limited experimental fishery for herring was undertaken between April 18-26, 1985 on offshore Scotian Shelf banks. The objective was to find and tag herring reported to be of much larger size than fish in the commercial fishery and possibly of a different stock. Three commercial purse seine vessels searched Emerald, Western, Sable Island, Middle and Banquereau Banks but found little evidence of herring. A few sets were made on Middle Bank but no fish were landed or tagged.

(iii) Larval herring survey

The 1985 larval survey was undertaken between Oct. 21 and Nov. 15. The standard survey of 115 stations was completed successfully.

ASSESSMENT INPUT DATA

Stock Components

As in previous assessments (e.g. Sinclair and Iles 1981), the 4WX fishery is divided into "stock" and "non-stock" components (Table 3). "Stock" fish are considered to belong primarily to the major SW Nova Scotia spawning groups, but this unit also encompases smaller local stocks (e.g. Grand Manan, Scotts Bay). The "non-stock" component is comprised of:

4Xb (N.B.) weirs 4Xb (N.B.) shutoffs	- considered to be migrants from the 5Y stocks
4Xa miscellaneous	- small localized Nova Scotia South Shore stocks caught in 4Xm gill, 4Xm trap and bycatches in handline and longline fisheries
4W miscellaneous	- 4W fish taken in gear other than purse seine, on the assumption that the fish are from local stocks.

Also, as in previous assessments, those segments of the fishery which span the winter months (4Wa and 4Xb purse seine) are considered on a quota year basis (October 15, 1983-October 14, 1984). All other segments are considered for the calendar year 1984.

Biological Sampling

As in previous years, sampling of commercial catches was stratified by area, gear segment and month following the guidelines of:

1) obtaining as many length frequencies from individual catches as possible; and

2) stratified "detail" samples (two fish per half cm size-class above 24 cm; one per half cm size-class below 24 cm) to a level of at least 200 fish per area, gear and month.

Sample coverage was high and resulted in 712 length frequencies and 13,102 fish analyzed in detail (including ages); however, some cells (area and gear by month) were undersampled according to the previous criteria (Table 6).

Biological samples were matched to landings by gear component on a monthly basis as in previous assessments. Numbers at age from commercial catches were generated on the St. Andrews HP 3000 in the traditional manner, using programs HERNLW02 and HERNAG09. For all gear components except 4Xa purse seine, length-frequency samples were applied on a monthly basis.

A correction of 2% was applied to length measurements to account for shrinkage due to freezing. This is between values of 3% (after 7 mo for Gulf herring, J. Hunt, pers. comm.) and 1% (after 3 days for 4X herring, unpubl. data) observed in two studies in St. Andrews.

Since the summer purse seine fishery involves several distinct fishing grounds and markets, including directed effort for ripe (roe) fish, a smaller spatial scale was considered necessary. As in the previous assessment, length frequencies were matched by individual 10' square and month. Catches were partitioned by square on the basis of logbook information and where samples and catches did not coincide, length-frequency information from adjacent squares was used.

Age Composition

The age composition of the nominal catch in major gear segments of the fishery is presented in Table 7 and Fig. 4. Age 3 (1982 year-class) dominated the 4WX stock by number and age 4 (1981 year-class) dominated by weight. Age 2 fish dominated the 4WX non-stock (primarily 4Xb) fishery both in number and weight.

Misreporting

The previous assessment dealt at length with the high degree of misreporting, particularly in the purse seine segment of this fishery, and employed an "adjusted" catch biomass about 1.7 times that reported. Drastic measures were taken in 1985 to curb misreporting (see Management Plan; Appendix 1), including:

- an increase in the TAC (to reduce the need or incentive to misreport)

- increased monitoring including nightly verbal hails before landing, as well as collection of delivery slips, purchase slips and log records.

- fragmented (weekly) license scheme.

The result was a significant improvement in the amount and quality of statistical information on which to base the assessment, and it was considered unnecessary to adjust the 1985 catch figures.

Abundance Indices

a) CPUE

Catch rates calculated as in previous assessments (Table 8) are not appropriate for use as independent checks on population estimates. Purse seine indices are complicated by a number of factors including historical misreporting and changing markets, New Brunswick weirs take non-stock fish, gillnet and Nova Scotia weirs were strongly influenced by markets. A new series of purse seine catch rates has been started - based upon intensive monitoring of the purse seine fleet (Mace 1985 and pers. comm.) and catch/effort information from the recently redesigned logbook. Initial values for this CPUE index are presented in Power and Stephenson (1986).

b) Larval abundance

The larval abundance index was again calculated as the mean number of larvae per m^2 to bottom (see Iles et al. 1985 for details of survey design and history of the index). The values for 1981-84 included additional stations in areas of high abundance. The index (Table 9) was recalculated on the basis of the original 115 standard stations, which resulted in a change in the values for 1981-84. The 1985 survey indicated the highest larval abundance since 1974.

ASSESSMENT PARAMETERS

A) Weights at Age

Table 10 shows the mean weights at age presented in previous assessment documents. In several cases, it is not clear how these were derived, or if they were used in projections. Table 11 presents mean weight at age calculated by month and weighted by gear for the stock components of the 1985 4WX fishery. As in the previous assessment, we have used July weight at age for the 4WX stock. We have extended the series using average July weights at age for the years 1979-83 (Sinclair et al. 1980) and our calculated values for 1984 and 1985 (Table 12). The 1985 weight at age (mean July, for stock fish weighted by gear) are:

	1985 weights at age (kg)								
Age	2	3	4	5	6	7	8	9	10
	.053	.118	.204	.249	.278	.315	.334	.344	.440

B) Catch Matrix

The catch matrix (Table 13) is an extension of the "adjusted" matrix (1973-84 adjustment to account for misreporting, omissions and previous errors: Mace (1985)) used in the previous assessment (Stephenson et al. 1985).

C) Partial Recruitment

A new partial recruitment vector was chosen after consideration of the pattern of the historical F matrix. This indicated a dome-shaped partial recruitment pattern with full recruitment at age 4. The PR vector chosen, and that used for 1984 are as follows:

Age	1	2	3	4	5	6	7	8	9	10	11
PR 1984	.003	.4	.75	1	1	.5	.5	.5	.5	.5	.5
PR 1985	.002	.5	1	1	1	1	1	1	1	1	1

D) Natural Mortality

Natural mortality was assumed to be 0.2.

ASSESSMENT RESULTS

SPA

Sequential population analysis (SPA) was calculated with larval abundance as in previous years. Regression of larval abundance on mature and 5+ biomass indicated a terminal F value of .25, based upon the best combination of high correlation coefficient, low intercept and minimum residuals (1973-81) (Table 14; Fig. 5). Cohort analysis ("COHORT" of Rivard 1982) indicates an increase in stock biomass over recent years (Table 15).

Trends in population biomass (age 2+ are as follows ('000 t):

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2+ biomass	458.7	373.6	278.8	242.6	376.1	403.4	372.8	380.5	426.5	504.8	590.1

Catch Projections

A catch projections was made using the following input:

Age	PR	Mean wt (kg)	1985 population Number	Weight (t)
1	.003	.0	1846300*	16706
2	.4	.053	1103025*	49199
3	.75	.118	1386999	135690
4	1.0	.204	960517	157726
5	1.0	.249	468454	94062
6	.5	.278	253757	60291
7	.5	.315	84230	22662
8	.5	.334	108780	31034
9	.5	.344	47854	14059
10	.5	.440	3810	1350

*Age 1 - population numbers set to long-term geometric mean (as in last assessment.
Age 2 - population numbers set to geometric mean 1973-83.

Assuming a 1986 catch of 110,600 t (1986 management plan) and $F_{0.1}$ = .3 thereafter, the following catch biomass is predicted (see also Table 16):

Quota/F				Projected catch biomass (t)			
86	87	88	89	86	87	88	89
110,600	.3	.3	.3	110,600	126,500	122,000	126,000

MANAGEMENT CONSIDERATIONS

a) Assessment

The terminal F value indicated by tuning with the larval abundance index is lower than that used in the past. Traditional catch rates from the fishery indicated a higher F, but these catch rates were not used because they were considered to be unreliable. It is noted that approximately 75% of the catch projected for 1987 is from ages only partially recruited to the 1985 fishery, and these are the ages for which there is the least confidence in prediction.

b) Misreporting

The steps taken in 1985 to reduce the level of misreporting resulted in a significant increase in the quality of information on which this assessment is based. The members of industry and of DFO Operations are to be commended on the improvement and encouraged to continue this effort.

c) Protection of the Trinity spawning component

The 1985 CAFSAC Advisory Document 85/16 expressed concern over the concentration of the fishery on the Trinity Ledge spawning unit and the situation appears to be getting worse. In 1985, 40% or more of the total stock catch was taken from the Trinity area, directly (during the spawning season), and, in addition, an unknown amount of this spawning group was taken by fisheries on mixed groups in other areas. The exact contribution of this spawning group to the whole stock is unknown, but it is almost certainly experiencing fishing pressure in excess of its relative contribution to the stock complex.

Several types of control are possible, including catch limits, time restriction, area limits (closures) and effort limits in the specific area. Closures would have the added benefit of reducing disturbance of spawning and of spawn on the bottom. If closures were imposed, it would also be appropriate to exclude towed gear from the area to prevent destruction of egg beds.

d) Recommendations for improvement of the assessment

The larval abundance index is an inherent part of the calibration of this assessment and continued investigation of its reliability is warranted. The larval abundance index does not provide information on incoming year-classes and investigation of potential indices of recruitment to the fishery and of the pattern of partial recruitment should be undertaken.

Knowledge of the importance of individual spawning units to the stock is becoming increasingly important as the roe fishery focusses effort on the Trinity Ledge area. Quantification of the relative size and integrity of individual spawning units must be addressed in light of continued pressure on these units.

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Table 1. Gear types involved in the 1985 4WX herring fishery.

Gear	Number	Landings Nominal (t)	% of total	Comments
Purse seine	41 vessels	101,337	71.4	Three fisheries: 4Xa summer 4Wa winter 4Xb fall & winter
Weirs	254 licensed	30,786	21.7	N.B. = 233 (154 successful) N.S. = 21 (16 ")
Gillnet 4W= 102 licensed vessels 4X= 245 " "		5,584	3.9	
Traps		1,304	0.9	
Shutoffs	44 licensed	1,139	0.8	4Xb
Midwater trawl	5 licenses	98	0.1	4Xb (one active)
Misc.		1,612	1.1	
		141,860		

Table 2. Approximate distribution of 1985 4WX herring landings among major markets (source R. Philpott, Marketing Directorate, DFO, Ottawa, pers. comm.)

Market	% by weight of catch	Notes
Roe	54	Ripe fish (based upon 6% recovery in processing)
Canned (sardine, etc.)	19	
Over side sales	11	>9.5"; <30% with feed
Bloater	4	(based upon 95% recovery in processing)
Others (frozen and cured)	13	

Table 3. Catch (t) by gear component and month for the 1985 4WX herring fishery (data from DFO, Scotia-Fundy Region, Statistics Branch; MFD Tape EMF701).

Gear segment	1984 Oct	1984 Nov	1984 Dec	1985 Jan	1985 Feb	1985 Mar	1985 Apr	1985 May	1985 June	1985 July	1985 Aug	1985 Sept	1985 Oct	1985 Nov	1985 Dec	Total
4WX stock																
4Wa purse seine	-	2379	2517	3452	403	-	-	-	-	-	-	-	-	1738[e]	2523[e]	8751
4Xa purse seine	-	-	-	-	-	-	-	-	290	12393	30646	37133	6705	-	-	87167
(domestic)									0	7986	26638	37133	6705			(78462)
(over side)									290	4407	4008	0	0			(8705)
4Xb purse seine	2431	1892	-	1096	-	-	-	-	-	-	-	-	1993[e]	637[e]	-	5419
4Xa gillnet[a]	-	-	-	-	-	-	-	88	86	60	1944	3406	-	-	-	5584
(domestic)								88	86	60	845	1524				(2603)
(over side)								0	0	0	1099	1882				(2981)
4Xa (NS) weirs	-	-	-	-	-	-	-	378	1803	1381	489	-	-	11	-	4062
4Xa (NS) traps[b]	-	-	-	-	-	-	-	190	446	406	201	47	13	1	-	1304
4Xb midwater trawl	-	-	-	-	52	6	40	-	-	-	-	-	-	-	-	98
Stock total	2431	4271	2517	4548	455	6	40	656	2625	14240	33280	40586	6718	12	-	112385
4WX non-stock																
4Xb (NB) weirs	-	-	-	-	-	-	-	23	84	4214	8451	6910	4825	2079	138	26724
4Xb (NB) shutoffs	-	-	-	-	-	-	36	-	-	73	184	208	288	306	44	1139
4Xab misc.[c]	-	-	-	-	12	-	-	2	19	292	146	20	2	-	-	493
4W misc.[d]	-	-	-	-	-	-	25	275	191	579	46	1	2	-	-	1119
Non-stock total	-	-	-	-	12	-	61	300	294	5158	8827	7139	5117	2385	182	29475
Total 4WX	2431	4271	2517	4548	467	6	101	956	2919	19398	42107	47725	11835	2397	182	141860

[a]4Xa gillnet includes 4XOQR (4Xm combined with 4Xa misc.).
[b]4X traps includes Liverpool but not 4Xm.
[c]4Xa misc. includes 4Xm gillnet, 4Xm traps, handline + longline bycatches.
[d]4W misc. includes all gear other than purse seine.
[e]Not included in totals for 1985 quota year.

Table 4. Historical series of annual landings (t) by major components of the 4WX herring fishery (1963-84 from Stephenson et al. 1985).

Year	4Wa	4Xa			4Xb		Stock total
	Purse seine	Purse seine	Gillnet	Weir	Purse seine	shutoff & weirs	
1963		15093	2955	5345	6871	29366	
64		24894	4053	12458	15991	29432	
65		54527	4091	12021	15755	33346	86394
66		112457	4413	7711	25645	35805	150226
67		117382	5398	12475	20888	30032	156741
68		133267	5884	12571	42223	33145	196362
69	25112	84525	3474	10744	13202	26539	150462
70	27107	74849	5019	11706	14749	15840	190382
71	52535	35071	4607	8081	4868	12660	129101
72	25656	61158	3789	6766	32174	32699	153449
73	8348	36618	5205	12492	27322	19935	122687
74	27044	76859	4285	6436	10563	20602	149670
75	27030	79605	4995	7404	1152	30819	143897
76	37196	58395	8322	5959	746	29206	115178
77	23251	68538	18523	5213	1236	23487	117171
78	17274	57973	6059	8057	6519	38842	95882
79	14073	25265	4363	9307	3839	37828	59021
80	8958	44986	19804	2383	1443	13525	79584
81	18588	53799	11985	1966	1368	19080	87706
82	12275	64344	6799	1212	103	25963	84733
83	8226	63379	8762	918	2157	11383	84385
84	6336	58354	4490	2684	5683	8698	78083
85	8751	87167	5584	4062	5419	27863	112385

Table 5. Summary of purse seine logbook coverage for the 1985 4WX herring fishery and traditional CPUE.

		4Xa	4Xb	4W
Number of vessels		41(100%)	4	6
Sets (records) covered by logs		2295	23	57
Stats Div. total successful nights (= trips)		1802		
Catch accounted for in logs	t	83317	1016	2779
	%	96	19	32
CPUE (t/successful night)		46.24	44.17	48.75

Table 6. Distribution of biological samples from the 1985 4WX commercial herring fishery; detail fish = number of fish taken for detail analysis including ageing, LF samples = number of length-frequency samples, LF fish = number of fish measured.

Gear component		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
4Wa purse seine	- detail fish		737	366	701	*										
	- LF fish		4445	2765	7381											
	- LF samples		22	14	37											
	- catch (t)		2379	2517	3452	403										
4Xa purse seine	- detail fish									86*	1080	1467	1085	467[b]		
	- LF fish									1708	22990	21841	6824	2986		
	- LF samples									8	110	110	42	19		
	- catch (t)									290	12393	30646	37133	6705		
4Xb purse seine	- detail fish	698[c]	230		100*											
	- LF fish	3286	1728		705											
	- LF samples	28	11		4											
	- catch (t)	2431	1892		1096											
4Xa gillnet (4XOQR)	- detail fish								*	*	*	265	217			
	- LF fish									180		4302	6111			
	- LF samples									1		22	28			
	- catch (t)								88	86	60	1944	3406			
4Xa NS weir (4XR)	- detail fish															
	- LF fish								134*	455	936	285				
	- LF samples								995	3770	5696	1383				
	- catch (t)								5	20	34	8				
4Xa NS trap (4XMOQ)	- detail fish								378	1803	1381	489			11	
	- LF fish								139*	102*	*	*				
	- LF samples								714	290						
	- catch (t)								3	2						
4Xb mid trawl	- detail fish				18*		166	40	190	446	406	201	47	13	1	
	- LF fish				142		2066	374								
	- LF samples				1		10	2								
	- catch (t)				52		6	40								
4Xb weirs	- detail fish								94	45*	1082	1129	761	706	134*	*
	- LF fish								1054	476	9796	9085	4898	4351	929	
	- LF samples								6	3	64	60	30	28	6	
	- catch (t)								23	84	4214	8451	6910	4825	2079	138
4Xb shutoff	- detail fish										*	14*	70*	122*	*	
	- LF fish											132	285	1245		
	- LF samples											1	2	8		
	- catch (t)							36			73	184	208	288	306	44
4WX misc.	- detail fish								139[a]	102[a]	87[a]	299[a]	217[a]			
	- LF fish								861	470	924	4520	5764			
	- LF samples								4	3	9	24	26			
	- catch (t)					12		25	277	210	871	192	21	4		

*Cells undersampled according to criteria of 200 detail fish per gear type per month with >50 t catch.
[a]Combined monthly detail and LF information used (4X gillnet, 4X trap + 4W gillnet);
[b]Oct. 1-14; [c]Oct. 15-31.

Table 7. Catch at age in numbers (thousands) and weight (t) by gear component for the 1985 4WX herring fishery.

		1	2	3	4	5	6	7	8	9	10	11+	Total
4WX "stock"													
4Wa purse seine	No.	0	11453	20489	12931	9403	3854	2027	1818	717	71	53	62816
	Wt.	0	835	2070	2048	1754	815	500	484	204	23	19	8751
4Xb purse seine	No.	5660	27227	17490	6760	3602	391	222	40	0	0	0	61392
	Wt.	68	1565	1875	1035	715	91	59	11	0	0	0	5418
4Xa purse seine	No.	0	43844	156606	156088	71307	20325	5964	8794	4066	586	94	467674
	Wt.	0	2752	21701	32400	17937	5604	1939	3088	1473	234	37	87167
4Xa gillnet	No.	0	0	4536	11402	6613	1501	254	519	185	20	19	25049
	Wt.	0	0	762	2401	1675	412	81	174	64	9	8	5584
4Xa(NS) weirs	No.	102	46704	12791	3851	1511	506	274	263	92	90	132	66316
	Wt.	5	1619	993	706	330	131	76	78	29	37	57	4062
4Xa(NS) traps	No.	0	77	3146	2337	1872	504	248	175	47	0	2	8408
	Wt.	0	3	301	365	390	118	62	51	14	0	1	1304
4Xb(NB) midwater trawl	No.	0	9114	541	0	0	0	0	0	0	0	0	9655
	Wt.	0	80	18	0	0	0	0	0	0	0	0	98
4WX "stock" total	No.	5762	138419	215599	193369	94308	27081	8989	11609	5107	767	300	701310
	Wt.	73	6854	27721	38955	22800	7171	2717	3885	1784	303	121	112385
4WX "non-stock"													
4Xb(NB) weirs	No.	15105	356632	44840	17702	7357	3488	304	71	73	0	0	445572
	Wt.	162	14443	5696	3536	1807	952	84	22	23	0	0	26725
4Xb(NB) shutoff	No.	5190	28749	1039	234	54	19	0	0	0	0	0	35285
	Wt.	65	876	136	44	13	5	0	0	0	0	0	1139
4WX misc.	No.	0	67	1550	1537	1952	1118	626	804	158	0	70	7882
	Wt.	0	2	135	269	439	271	172	247	55	0	20	1611
4WX "non-stock" total	No.	20295	385448	47429	19473	9363	4625	930	875	231	0	70	488739
	Wt.	226	15321	5967	3850	2260	1227	256	269	78	0	20	29475
4WX GRAND TOTAL	No.	26057	523867	263028	212842	103671	31706	9919	12484	5338	767	370	1190049
	Wt.	299	22175	33688	42805	25060	8399	2974	4154	1862	303	141	141860

Table 8. Traditional CPUE trends for components of the 4WX herring fishery. Data for 1965-84 as in Stephenson et al. (1985).

Year	Purse seine			Fixed gear	
	4Xa[a]	4Wa[a]	4Xa gillnets[b]	4Xa NS weirs[c,d]	4Xb NB weirs[c,e]
1965	-	-		481	162
1966	-	-		308	183
1967	55.5	-		499	153
1968	52.8	-		503	165
1969	41.7	-		430	132
1970	39.0	-		468	77
1971	32.6	109.7		323	62
1972	45.0	62.6		271	164
1973	49.1	69.7		500	98
1974	53.4	143.1		257	98
1975	57.4	142.7		296	158
1976	44.6	125.4		238	150
1977	37.4	97.9	4.2	209	106
1978	39.5	85.7	1.6	269	172
1979	31.7	70.1	2.1	372	167
1980	28.5	63.4	3.0	95	57
1981	42.0	76.8	4.4	79	80
1982	40.6	68.7	3.44	48	114
1983	34.8	51.0	2.29	37	54
1984	52.0	27.8	2.12	107	43
1985	46.2	48.8	2.29*	172	137

[a]Catch (t) per successful night (= trip).
[b]t/purchase slip (areas 32-37).
[c]t/weir.
[d]No. of weirs = 25.
[e]No. of weirs = 195.
*Preliminary.

Table 9. Traditional 4WX larval herring abundance indices; from number of larvae per m^2 (to bottom) of standard stations sampled (n=115) for each year. Values for 1981-84 have been revised; unrevised values are in brackets.

Year	Geometric mean
1972	2.64
1973	2.30
1974	7.60
1976	4.44
1977	1.83
1978	1.24
1979	2.18
1980	4.61
1981	1.40 (1.50)
1982	3.79 (3.73)
1983	3.32 (4.29)
1984	4.31 (5.13)
1985	6.63

Table 10. Mean weight at age for 4WX herring as presented in annual assessment documents for 1973-84.

Age	1973 ICNAF Res. Doc. 74/13	1975 ICNAF Res. Doc. 76/VI/45	1976 CAFSAC Res. Doc. 77/11	1977 CAFSAC Res. Doc. 78/25	1978 CAFSAC Res. Doc. 79/19	1979 CAFSAC Res. Doc. 80/47 . Option 1	1980 CAFSAC Res. Doc. 81/10[a]	1981 CAFSAC Res. Doc. 82/36[b]	1982 CAFSAC Res. Doc. 83/89[c]	1983 CAFSAC Res. Doc. 84/72[d]	1984 CAFSAC Res. Doc. 85/78[e]
1	-			-	9	10.64	9.5	-	8.54	10	-
2	31			29.6	30	24.37	35.5	19	51.79	41	37.5
3	114			97.7	93	93.93	86.9	35	137.42	112	132.1
4	159	"as per	"mean wts	165.8	159	164.75	173.4	172	176.26	172	191.4
5	227	assessment	from 4XWb	207.1	205	226.00	220.7	216	229.67	218	228.7
6	270	presented	were used"	261.5	250	253.13	258.3	202	256.34	254	259.1
7	299	in Jan.		280.7	285	285.86	305.3	262	287.47	286	279.8
8	334	1976"		300.2	315	314.75	333.0	325	319.62	323	296.2
9	360			328.6	341	343.85	359.2	362	362.61	354	309.0
10	386			349.0	382	369.52	369.7	385	377.64	389	364.0

[a]Also first use of 'Mean July 1969 to 1978' as used in 'W83'. Used both 'Fishery' and 'Mean' in cohort mean for projections.
[b]As for a), i.e. fishery and mean for cohort and YPR but mean for projections.
[c]Used 'mean July 1969 to 1978' only. No fishery weights calculated.
[d]Also used mean July 1969 to 1978 weights which are different from a).
[e]Mean July weights at age (stock fish weighted by gear).

Table 11. Mean weights at age calculated by month and weighted gear for the stock portion (Gear 01 to Gear 07) of the 1985 4WX herring fishery.

	Month														
	1984			1985											
Age	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	14	11	0	0	0	0	0	0	52	0	0	0	0	0	0
2	61	59	72	33	0	9	0	23	37	53	61	62	81	0	0
3	131	133	126	72	0	33	0	58	82	118	147	146	130	0	0
4	179	173	179	127	0	0	0	129	167	204	214	206	185	0	0
5	208	207	201	176	0	0	0	175	209	249	258	252	221	0	0
6	255	233	239	207	0	0	0	188	243	278	282	276	247	0	0
7	269	245	247	247	0	0	0	221	255	315	330	331	274	0	0
8	286	264	271	265	0	0	0	272	293	334	351	352	327	0	0
9	0	289	293	283	0	0	0	0	301	344	366	367	321	0	0
10	0	336	330	318	0	0	0	0	394	440	399	396	0	0	0
11	0	359	0	354	0	0	0	258	394	446	404	417	0	0	0

Table 12. July weights at age for the 4WX herring fishery (stock portion); 1968-85. Values for 1968-78 from Sinclair et al. (1980, CAFSAC Res. Doc. 80/21); values for 1979-83 are averages for the period 1968-78 (as in Iles et al. 1984, CAFSAC Res. Doc. 84/72); 1984 and 1985 values calculated from the respective fishery (Stephenson et al. 1985).

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	0	0
2	33	37	32	66	44	29	48	21	33	65	28	41	41	41	41	41	38	53
3	33	106	119	143	138	106	110	94	114	113	112	112	112	112	112	112	132	118
4	148	162	169	199	192	143	175	179	159	174	181	172	172	172	172	172	191	204
5	185	207	211	230	225	225	206	216	233	214	229	218	218	218	218	218	229	249
6	244	242	257	254	262	251	240	240	249	274	259	254	254	254	254	254	259	278
7	276	282	292	293	292	279	277	268	277	293	302	286	286	286	286	286	280	315
8	399	306	332	329	322	331	322	333	317	325	330	323	323	323	323	323	296	334
9	338	334	369	362	345	360	342	358	382	328	351	354	354	354	354	354	309	344
10	409	390	389	388	380	389	352	379	404	416	397	389	389	389	389	389	364	440

Table 13. Catch matrix (no. x 1000) for the stock portion of the 4WX herring fishery (includes adjusted 1973-84 portion used in last assessment; Stephenson et al. 1985).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	270378	154323	722208	164703	108875	699720	87570	0	1018	18411	3199
2	1084719	914093	613970	2389061	290329	576896	404224	649254	167454	766064	317640
3	34835	448940	153626	224956	531812	76532	183896	71984	781061	93606	239827
4	234383	73382	266454	83109	132319	286278	106630	148516	130851	803651	124599
5	49925	321857	110051	290285	162439	201215	113566	77207	40128	68276	514605
6	10592	45916	159203	73087	112631	120280	75593	75384	30334	19093	66302
7	1693	13970	57948	90617	62506	111937	93620	49065	22046	10232	12298
8	561	7722	4497	31977	22595	41257	50022	48700	20249	6565	4409
9	54	1690	409	15441	6345	21271	36618	26055	23871	12785	4778
10	37	215	296	5668	2693	7039	7536	13792	11630	7102	3847

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	240	1170	35381	342	2339	0	3589	5488	0	5762
2	55596	153921	383611	183982	12503	103051	102133	191682	88433	138419
3	206535	31572	40887	250393	80518	50883	150764	150328	243542	215599
4	153782	218478	12906	54620	474091	102743	22640	244007	224354	193369
5	68804	119234	122108	5430	27929	451482	98206	24483	146096	94308
6	268839	51173	68410	23142	4373	32978	211043	60678	22716	27081
7	21460	177247	31088	18255	4692	2418	14627	89982	21654	8989
8	5571	13977	108975	11836	6560	2766	2080	10352	28299	11609
9	3951	3170	11082	41389	2985	1917	1354	1728	9515	5107
10	2059	1415	2425	4527	10641	538	1250	642	2183	767

Table 14. Results of initial tuning runs - 4WX herring: Intercepts and r of the regression of SPA derived biomass vs larval abundance.

Terminal F	SPA mature biomass r	SPA mature biomass Intercept	SPA 5+ biomass r	SPA 5+ biomass Intercept
.2	.79	123358	.86	41100
.25	.81	129384	.87	46320
.3	.78	133325	.84	49785

Table 15. 4WX herring: a) population numbers (thousands), b) population biomass (t) and c) table of F values from sequential population analysis.

a)

POPULATION NUMBERS

	1965	1966	1967	1968	1969	1970	1971
1	3562193	2773236	6160139	1295598	1773851	2357424	7574118
2	3927355	2671828	2130896	4390015	911716	1353792	1296962
3	1002620	2233952	1360403	1189087	1432528	483750	586394
4	1328174	789356	1422788	974797	769994	691652	326812
5	344501	875339	579871	923782	722896	510690	307241
6	97053	236880	425438	375180	493668	444876	236051
7	58313	69877	152394	204267	241039	302269	255400
8	4848	46210	44570	72336	85246	140789	146192
9	1195	3462	30847	32421	30290	49349	77937
10	227	929	1305	24885	12573	19058	21156
1+	10326479	9701069	12308651	9482368	6473802	6353648	10828265
2+	6764287	6927833	6148511	8186771	4699951	3996224	3254146
3+	2836931	4256004	4017615	3796756	3788234	2642432	1957184
4+	1834312	2022052	2657212	2607669	2355706	2158682	1370790

	1972	1973	1974	1975	1976	1977	1978
1	1147833	2372431	1650228	259459	728406	4325141	1571513
2	6121927	939766	1941461	1334434	209532	596151	3540068
3	696106	4424741	617896	896371	805129	121246	348814
4	313703	504790	2915937	421193	516882	472303	70700
5	171088	122456	294888	1660194	232101	284039	189002
6	148789	70215	63949	179655	893618	127772	124664
7	124863	53608	30040	35081	87096	488377	58308
8	124393	57833	23942	15336	17594	51891	239470
9	74430	57779	29027	13662	8567	9364	29838
10	30676	37363	25706	12197	6862	3438	4797
1+	8953808	8640981	7593075	4827581	3505787	6479721	6177174
2+	7805975	6268549	5942847	4568122	2777381	2154580	4605661
3+	1684048	5328784	4001386	3233689	2567849	1558429	1065593
4+	987942	904043	3383490	2337318	1762720	1437183	716779

	1979	1980	1981	1982	1983	1984	1985
1	554852	1930747	1980069	2414420	2194598	1956912	8479598
2	1254632	453965	1578645	1539271	1973512	1791819	1602184
3	2551257	860732	360361	1199241	1167835	1442334	1386999
4	248588	1862228	631852	248998	845439	820120	960517
5	46206	154104	1095688	424351	183377	471400	468454
6	44254	32918	100898	488556	258569	127983	253757
7	40166	15292	22994	52769	209036	156795	84230
8	19609	16367	8275	16638	29968	89725	108780
9	97456	5345	7465	4271	11740	15169	47854
10	14401	42340	1675	4377	2272	8048	3810
1+	4871422	5374039	5687923	6392892	6876345	6880305	13396183
2+	4316570	3443292	3807854	3978472	4681747	4923393	4916584
3+	3061939	2989327	2229209	2439202	2708235	3131574	3314400
4+	510681	2128596	1868847	1239960	1540400	1689241	1927400

Table 15. (cont'd)

b) *MEAN POPULATION BIOMASS (t)*

	1965	1966	1967	1968	1969	1970	1971	1972
1	30957	24380	52252	10924	15544	17747	68223	10403
2	123060	79659	66193	86356	25120	29075	63825	231578
3	99875	201373	129574	31826	107349	47700	62163	81918
4	186804	116829	198725	124702	102491	79919	47905	39095
5	62640	135938	102487	126712	118660	74949	50282	25427
6	21011	48652	76568	74097	94344	87677	44277	24429
7	14880	16095	30728	37550	52577	62783	53304	25387
8	1330	12278	12330	19272	20082	35286	34953	27946
9	374	783	9827	7078	8090	12269	18349	18556
10	73	285	402	8064	3919	5294	5915	7779
1+	541003	636273	679086	526581	548177	452699	449195	492518
2+	510046	611893	626834	515656	532633	434952	380972	482114
3+	386986	532234	560641	429300	507513	405877	317147	250536
4+	287111	330860	431067	397474	400164	358177	254984	168619

	1973	1974	1975	1976	1977	1978	1979	1980
1	21498	14867	2336	6601	39195	14071	5027	17488
2	22107	64503	21790	5277	30089	85430	42859	16620
3	382429	56563	65001	71197	10618	33168	245134	82925
4	55956	391043	56799	61876	53885	10412	33986	248580
5	20227	47809	266824	40793	41359	22792	8543	27387
6	11901	11534	30630	167277	24279	19293	6923	7026
7	10272	6063	6778	18844	102335	10728	7582	3268
8	13840	5902	3873	4140	12964	52160	3545	3663
9	14252	6646	3533	2148	2240	7438	23404	1120
10	10843	6925	3439	2087	985	1205	4171	12827
1+	563324	611856	461004	380241	317948	256696	381174	420904
2+	541827	596988	458668	373640	278753	242625	376146	403416
3+	519719	532485	436878	368363	248664	157195	333287	386796
4+	137291	475922	371877	297166	238046	124027	88153	303871

	1981	1982	1983	1984	1985
1	17040	21866	19864	17736	76827
2	56591	55146	69457	59323	73126
3	33741	113350	110181	156516	135690
4	89653	36897	110134	120193	157726
5	163869	72952	33577	80358	94063
6	18860	83631	51678	27100	60291
7	5618	11526	40346	36750	22662
8	1955	4537	7021	19729	31034
9	2048	1121	3461	2540	14059
10	483	1295	673	2250	1431
1+	389858	402320	446392	522496	666908
2+	372818	380454	426528	504759	590081
3+	316227	325309	357071	445437	516955
4+	282486	211959	246891	288921	381265

Table 15. (cont'd)

c) *FISHING MORTALITY*

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.088	0.063	0.139	0.151	0.070	0.398	0.013	0.000	0.000	0.012	0.014
2	0.364	0.475	0.383	0.920	0.434	0.637	0.422	0.125	0.219	0.573	0.305
3	0.039	0.251	0.133	0.235	0.528	0.192	0.426	0.121	0.217	0.183	0.351
4	0.217	0.108	0.232	0.099	0.211	0.611	0.447	0.741	0.338	0.363	0.396
5	0.175	0.521	0.235	0.427	0.285	0.572	0.525	0.691	0.450	0.296	0.419
6	0.129	0.241	0.534	0.242	0.291	0.355	0.437	0.821	0.649	0.400	0.524
7	0.033	0.250	0.545	0.674	0.338	0.526	0.519	0.570	0.606	0.472	0.490
8	0.137	0.204	0.118	0.671	0.347	0.391	0.475	0.567	0.489	0.361	0.382
9	0.051	0.776	0.015	0.747	0.263	0.647	0.732	0.489	0.610	0.667	0.489
10	0.197	0.293	0.286	0.288	0.268	0.518	0.494	0.674	0.417	0.361	0.424
4+	0.198	0.311	0.295	0.306	0.269	0.523	0.496	0.680	0.423	0.362	0.424

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.000	0.000	0.025	0.001	0.001	0.000	0.002	0.003	0.000	0.001
2	0.347	0.336	0.128	0.177	0.031	0.075	0.076	0.114	0.056	0.100
3	0.333	0.339	0.139	0.115	0.109	0.170	0.150	0.153	0.207	0.188
4	0.399	0.716	0.225	0.278	0.330	0.198	0.106	0.384	0.360	0.250
5	0.397	0.623	1.252	0.139	0.224	0.608	0.295	0.160	0.419	0.250
6	0.404	0.585	0.933	0.863	0.159	0.448	0.649	0.300	0.218	0.125
7	0.318	0.513	0.890	0.698	0.414	0.124	0.366	0.646	0.166	0.125
8	0.431	0.353	0.699	1.100	0.585	0.461	0.149	0.481	0.429	0.125
9	0.713	0.469	0.528	0.634	0.960	0.334	0.431	0.178	1.182	0.125
10	0.399	0.597	0.799	0.422	0.323	0.434	0.375	0.371	0.353	0.125
4+	0.399	0.602	0.848	0.453	0.324	0.453	0.398	0.379	0.359	0.218

Table 16. Catch projection (population numbers (thousands), catch biomass (t) and F matrix) for 4WX herring assuming a 1986 catch of 110,600 and 1987+ catch at $F_{0.1}$ = .3.

POPULATION NUMBERS 86/07/28

	1985	1986	1987	1988	1989	1990	1991	1992
1	1846300	1846300	1846300	1846300	1846300	1846300	1846300	1846300
2	1103025	1506418	1510508	1510263	1510263	1510263	1510263	1510263
3	1386999	778351	1117824	1096854	1096676	1096676	1096676	1096676
4	960517	941428	529943	730799	717090	716974	716974	716974
5	468454	612452	602761	321427	443252	434937	434866	434866
6	253757	298699	392130	365593	194955	268846	263803	263760
7	84230	183346	216264	276330	257629	137383	189453	185899
8	108780	60858	132746	152398	194726	181548	96812	133505
9	47854	78596	44062	93545	107393	137221	127935	68222
10	3810	34576	56905	31050	65920	75679	96698	90154
1+	6263725	6341025	6449444	6424559	6434204	6405826	6379779	6346618
2+	4417425	4494725	4603144	4578259	4587904	4559526	4533479	4500318
3+	3314400	2988308	3092636	3067996	3077642	3049263	3023216	2990056
4+	1927400	2209956	1974812	1971142	1980966	1952587	1926540	1893380

CATCH BIOMASS 86/07/28

	1985	1986	1987	1988	1989	1990	1991	1992
1	58	12	15	15	15	15	15	15
2	7313	6767	8195	8194	8194	8194	8194	8194
3	25442	14062	24179	23725	23721	23721	23721	23721
4	39432	38083	25512	35182	34522	34516	34516	34516
5	23516	30295	35483	18921	26093	25603	25599	25599
6	7536	8733	13811	12877	6867	9469	9291	9290
7	2833	6070	8625	11021	10275	5479	7556	7414
8	3879	2137	5614	6445	8235	7678	4094	5646
9	1757	2841	1919	4074	4677	5976	5572	2971
10	337	1598	3169	1729	3671	4214	5384	5020
1+	112102	110600	126522	122183	126269	124866	123943	122387
2+	112045	110588	126507	122168	126254	124851	123928	122372
3+	104732	103820	118312	113974	118061	116657	115734	114178
4+	79290	89758	94133	90249	94339	92936	92013	90457

FISHING MORTALITY 86/07/28

	1985	1986	1987	1988	1989	1990	1991	1992
1	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2	0.149	0.098	0.120	0.120	0.120	0.120	0.120	0.120
3	0.187	0.184	0.225	0.225	0.225	0.225	0.225	0.225
4	0.250	0.246	0.300	0.300	0.300	0.300	0.300	0.300
5	0.250	0.246	0.300	0.300	0.300	0.300	0.300	0.300
6	0.125	0.123	0.150	0.150	0.150	0.150	0.150	0.150
7	0.125	0.123	0.150	0.150	0.150	0.150	0.150	0.150
8	0.125	0.123	0.150	0.150	0.150	0.150	0.150	0.150
9	0.125	0.123	0.150	0.150	0.150	0.150	0.150	0.150
10	0.250	0.123	0.150	0.150	0.150	0.150	0.150	0.150
1+	0.136	0.119	0.140	0.137	0.140	0.140	0.140	0.140

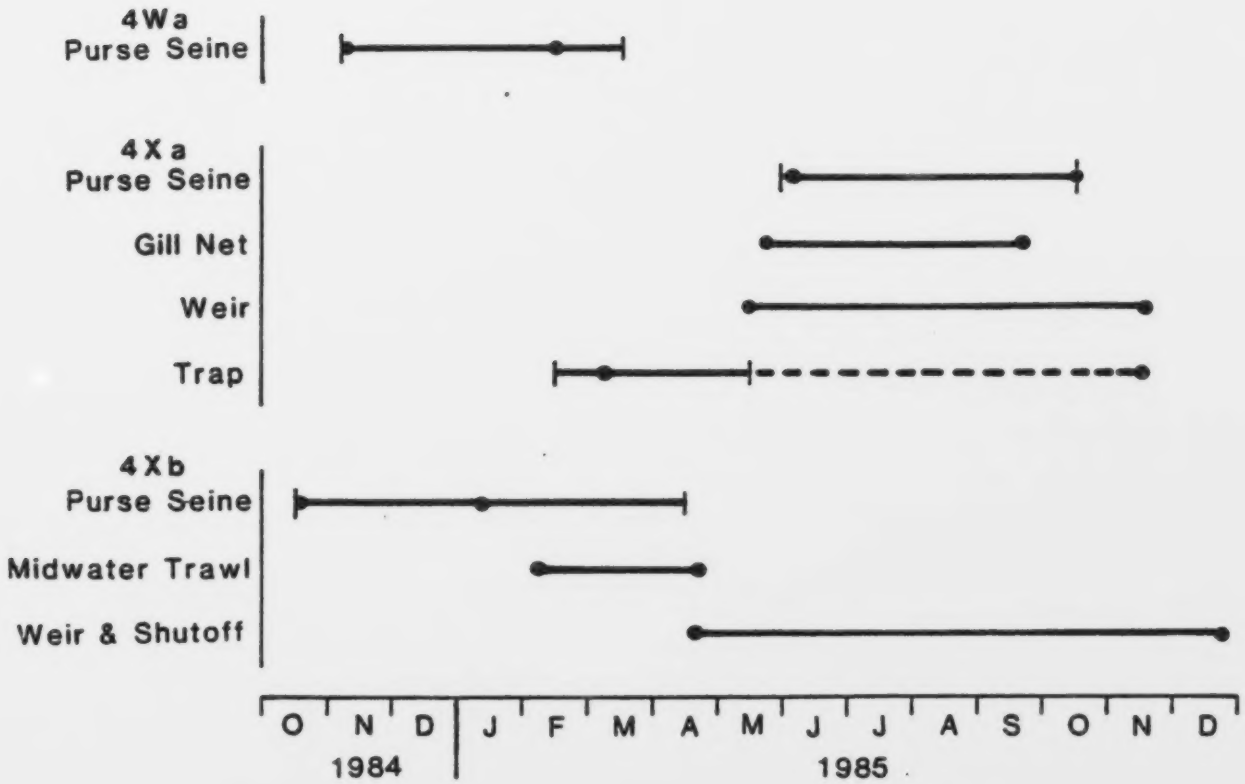


Fig. 1. Seasonal distribution of activity by gear component of the 1985 4WX herring fishery. Dots (•—•) represent recorded limits of fishing activity; bars (|—|) represent limits of seasons.

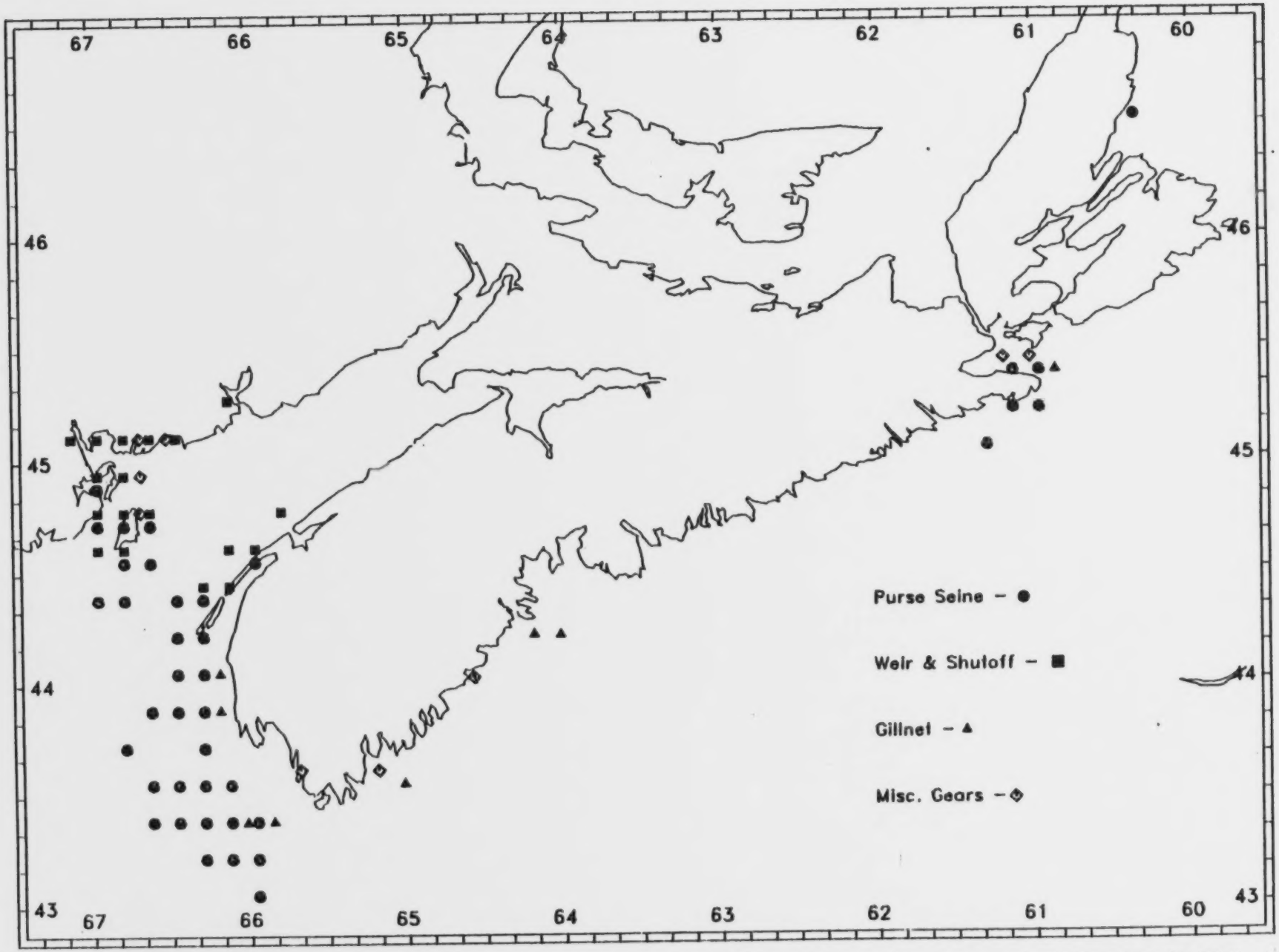


Fig. 2. Geographical distribution of gear components of the 1985 4WX (and 4Vn purse seine) herring fishery (resolution = 10' square).

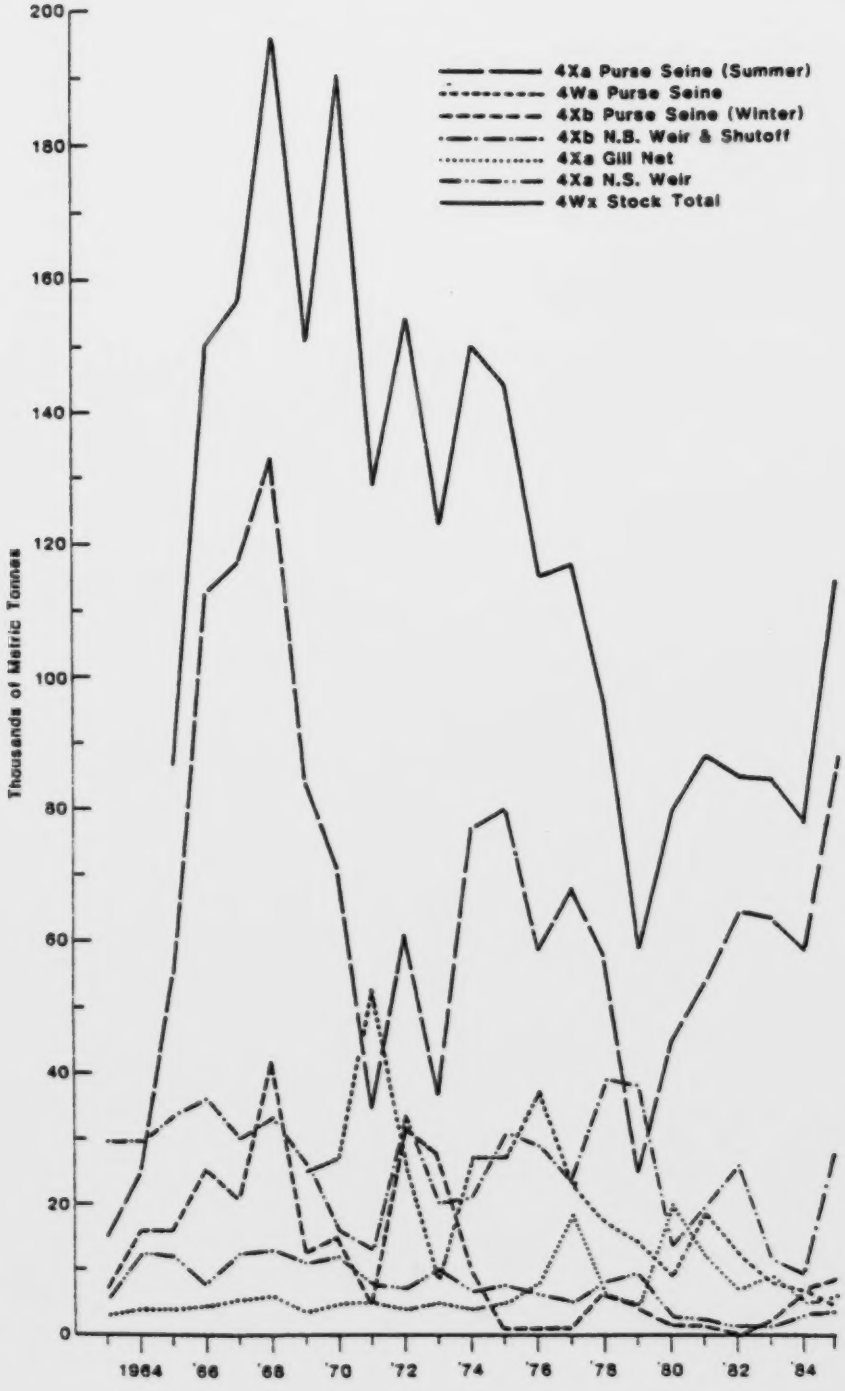


Fig. 3. Long-term (1963-present) landings by gear component of the 4WX herring fishery.

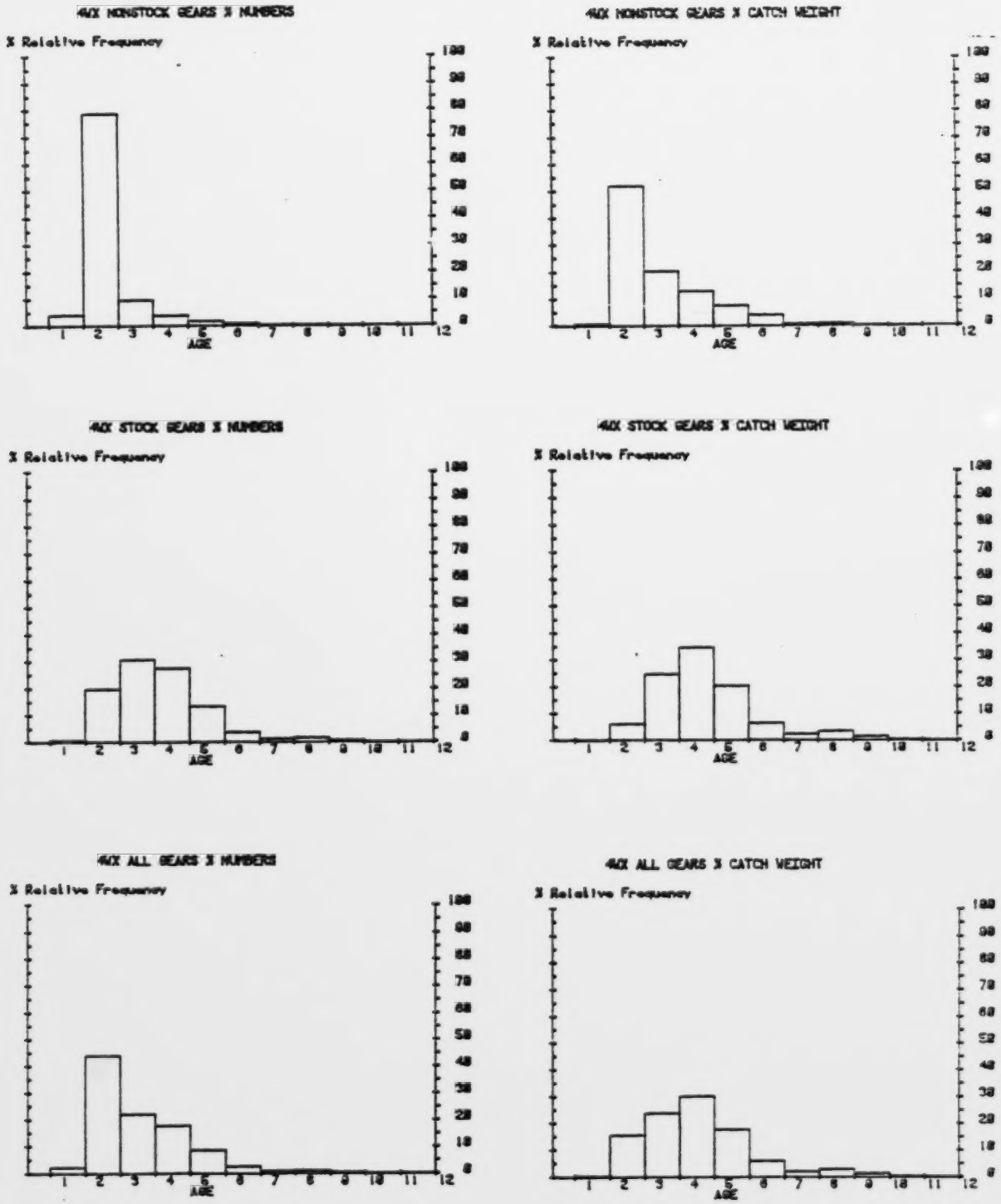
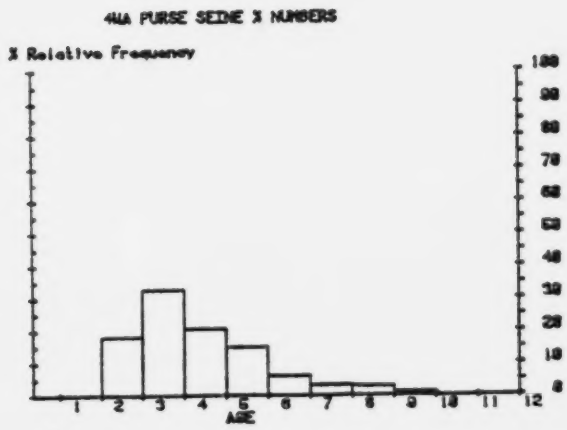
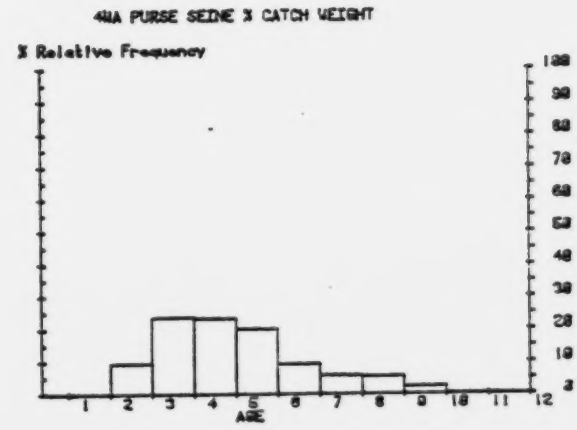
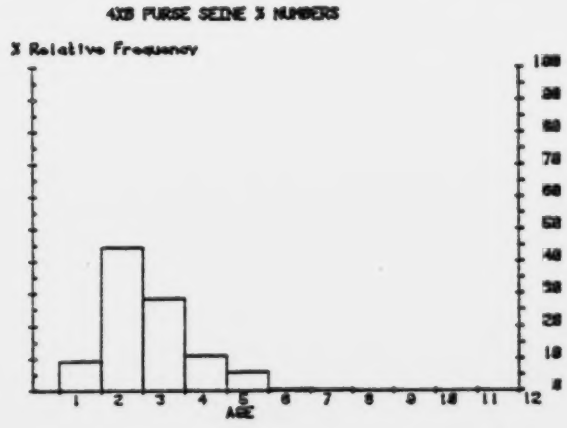
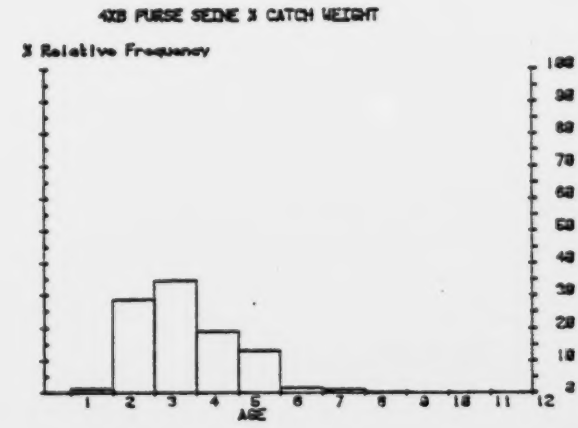


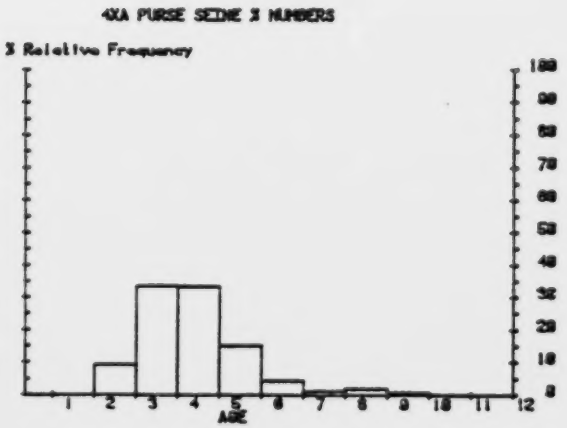
Fig. 4. Relative frequency (%) of numbers and weights by age in gear segments of the 1985 4WX herring fishery.











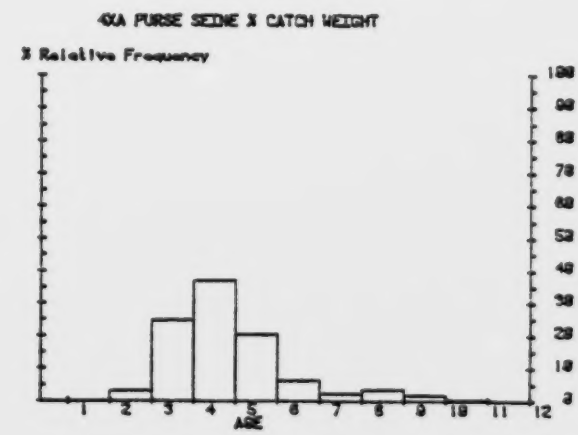
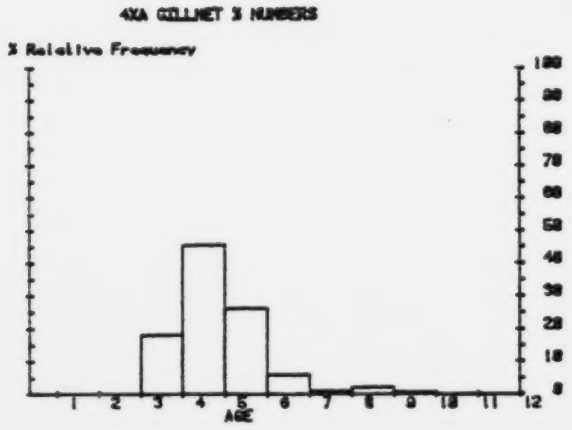
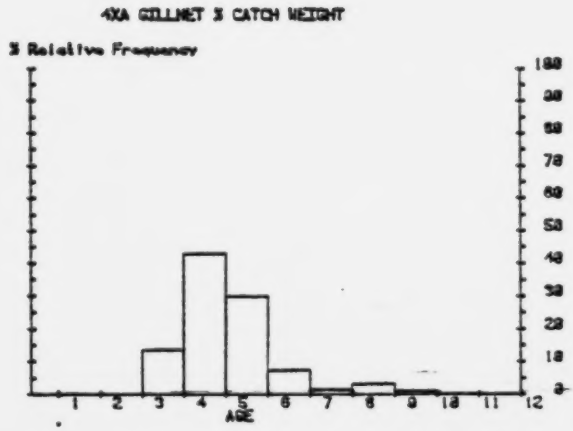
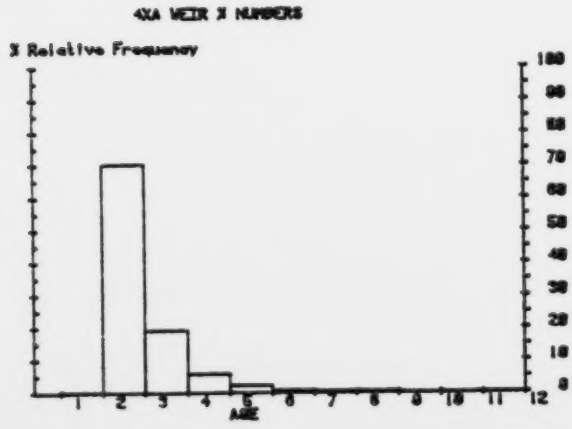
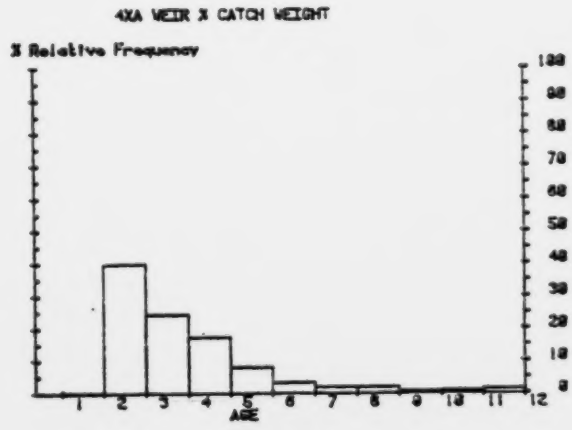


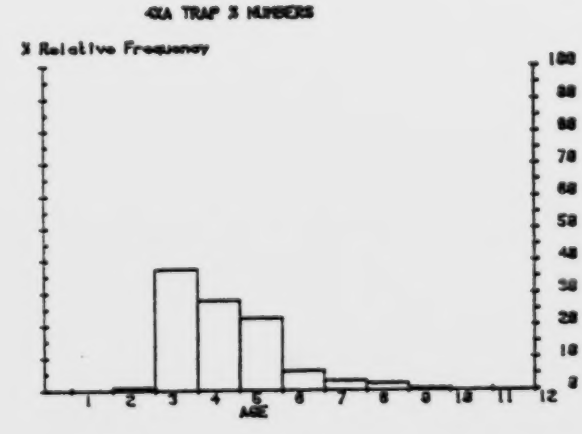
Fig. 4 Continued.











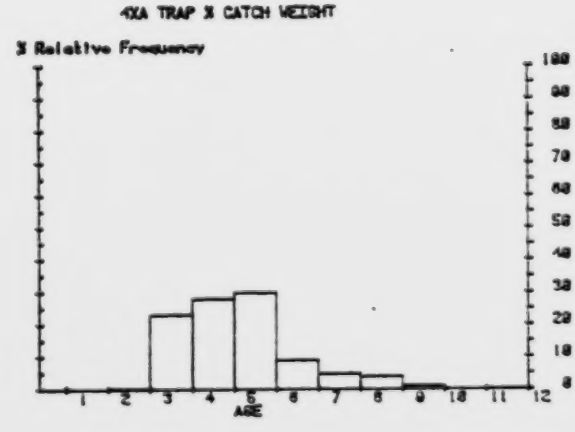
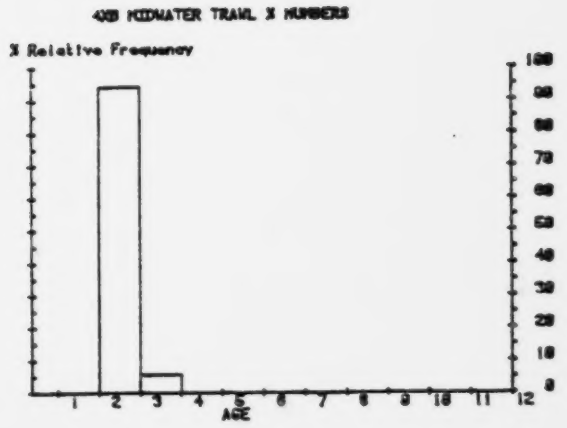
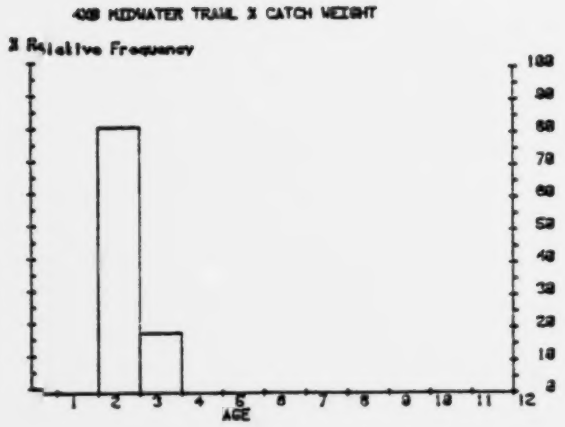
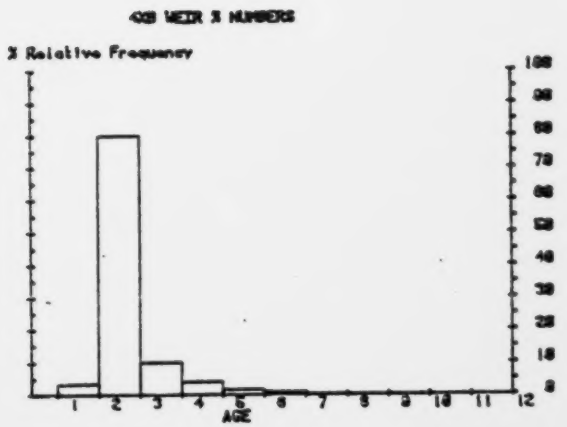
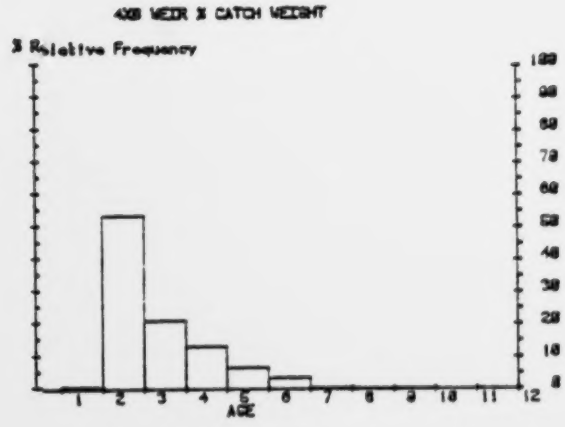


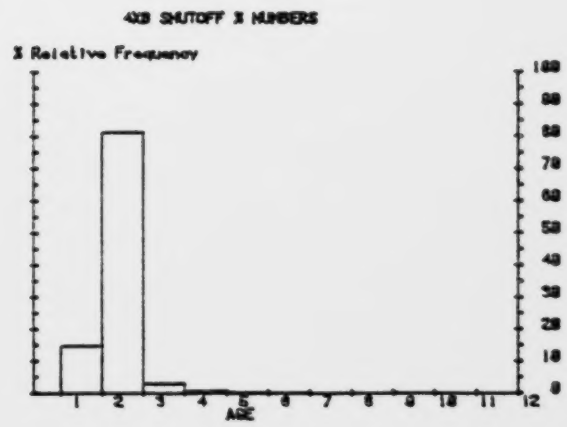
Fig. 4 Continued.











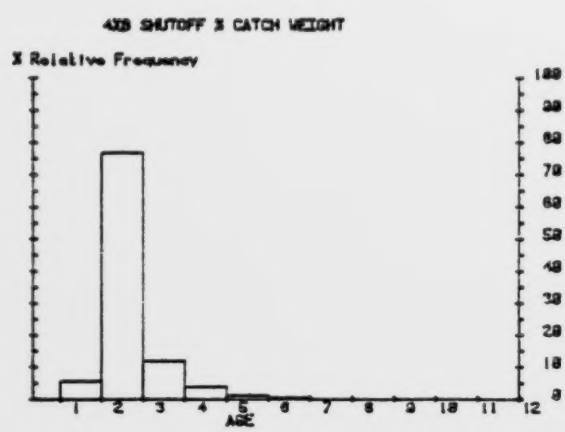
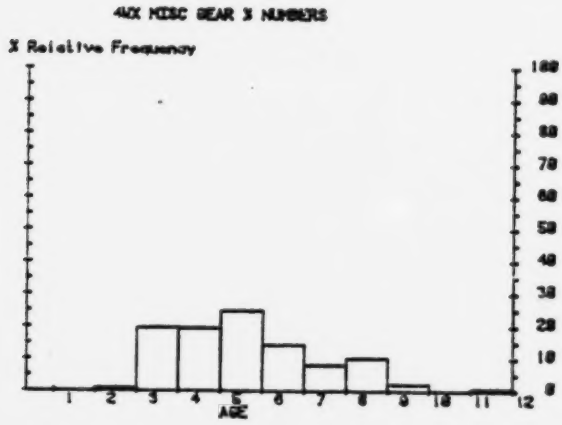


Fig. 4 Continued.



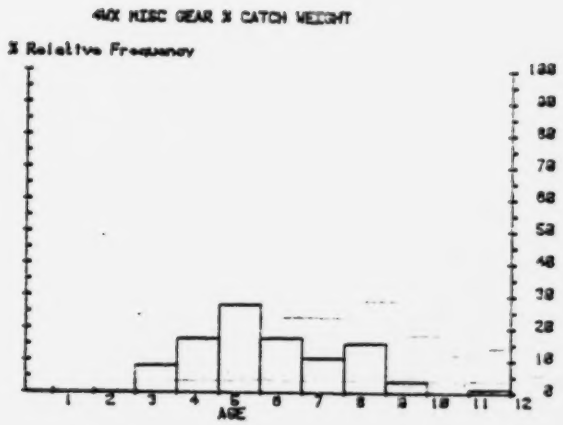


Fig. 4 Continued.

REGRESSION

Y = 129348.2847 + 43563.97979 X
STUDENT T: 4.623822846 R SQUARED: 0.6602813742
R: 0.8125769958

PLOT OF "SPA" ESTIMATES (o) AND PREDICTED VALUES (+)
AGAINST THE CALIBRATION VARIABLE:

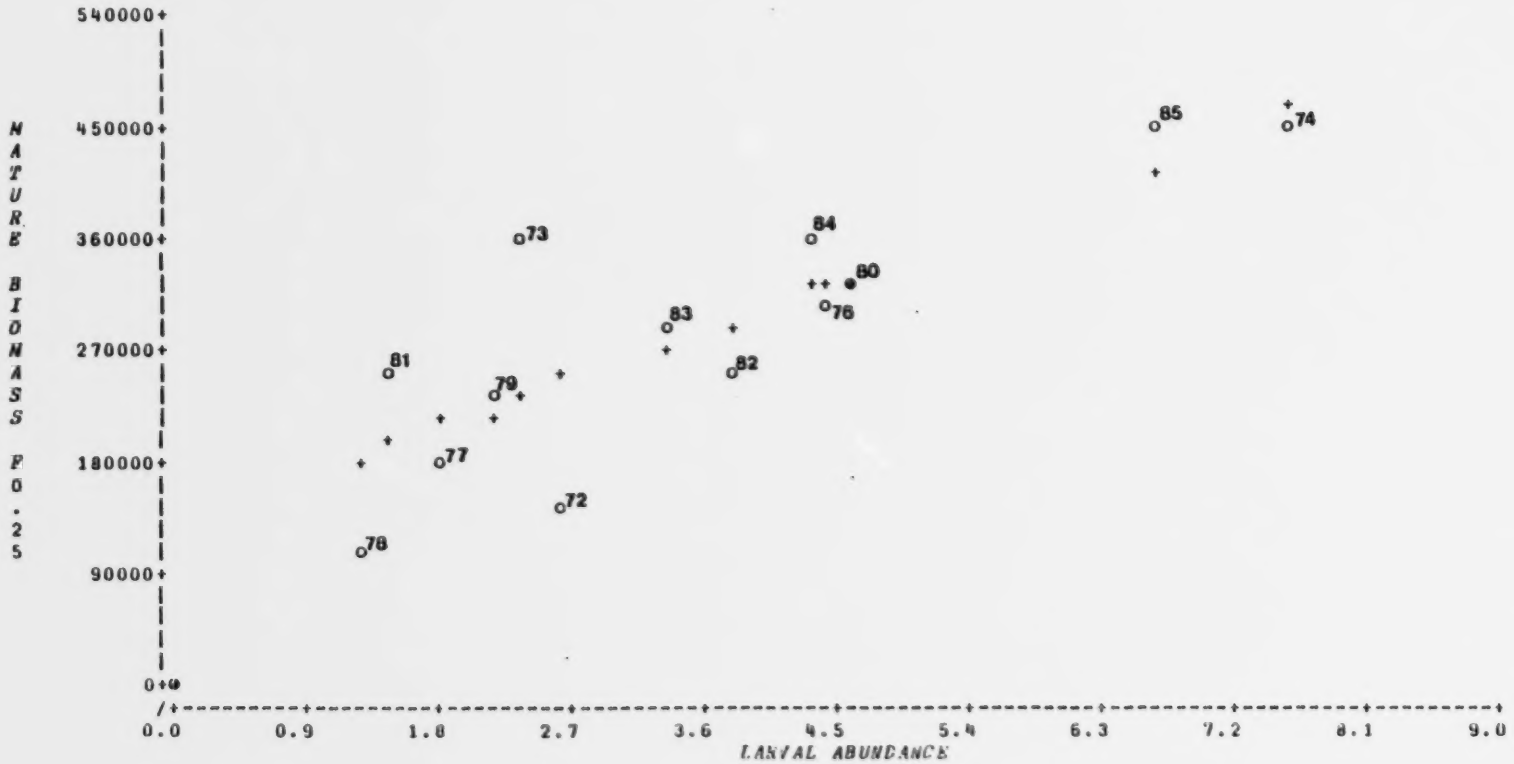


Fig. 5a. "Tuning" plot of 4WX herring SPA derived mature vs larval abundance; 1972-1985.

REGRESSION

Y = 46320.17187 + 47170.83419 X
STUDENT T: 5.708696704 R SQUARED: 0.7476440164
R: 0.8646641061

PLOT OF "SPA" ESTIMATES (o) AND PREDICTED VALUES (+)
AGAINST THE CALIBRATION VARIABLE:

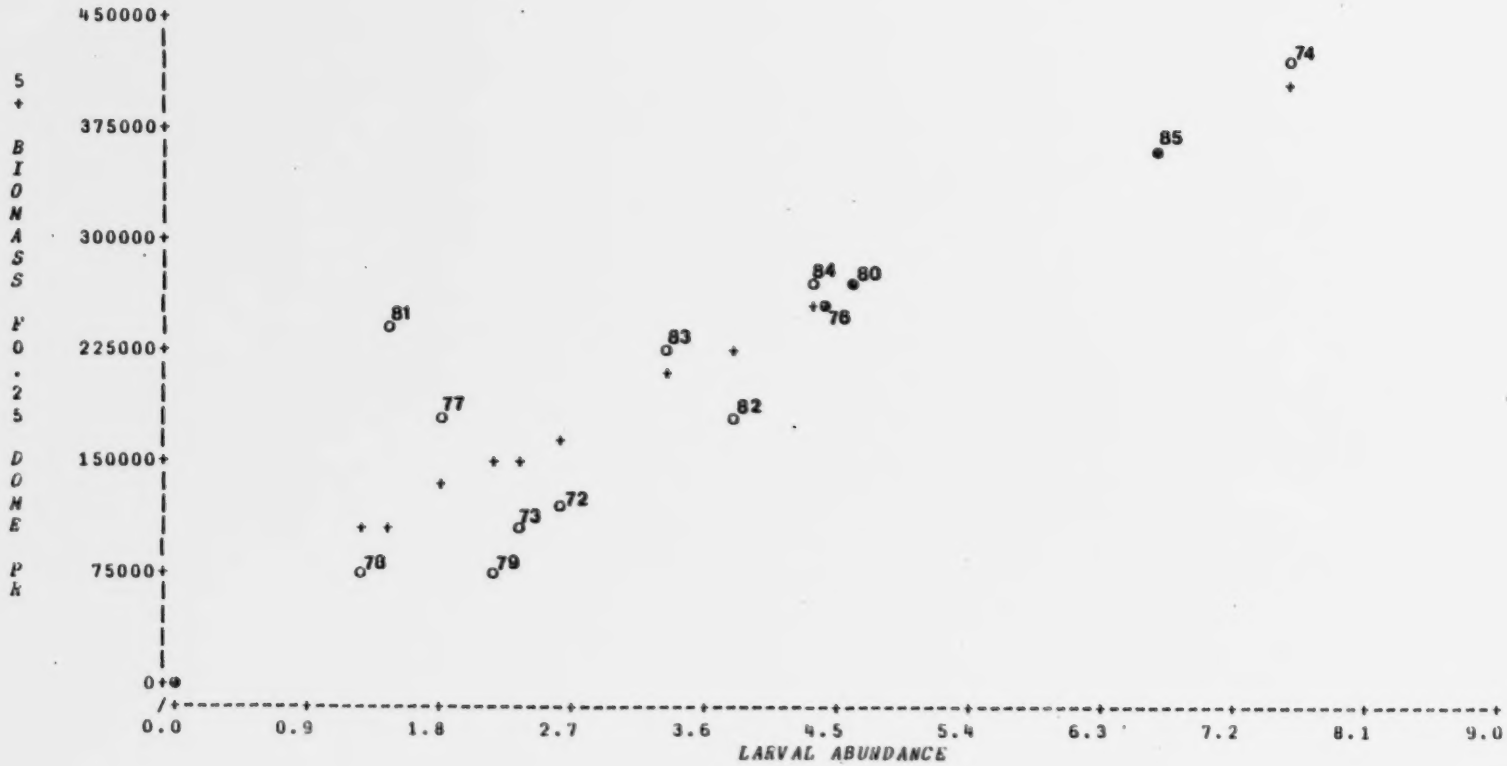


Fig. 5b. "Tuning" plot of 4WX herring SPA derived 5+ biomass vs larval abundance; 1972-1985.

APPENDIX 1

1985 HERRING MANAGEMENT PLAN

SCOTIA-FUNDY REGION
(4Vn - 4WX)

BASIC PRINCIPLES

1. Conservation and restoration of the fisheries resource.

2. Quotas for purse seine vessels are to be issued by stock area and by fleet segment.

3. Utlization of the fishery resources over the calendar year to the degree possible and among competing end product users so as to maximize the overall value of the resource.

4. Industry/government co-management of quotas to occur.

PART I

HERRING PURSE SEINE FLEET

I. GENERAL

THE TOTAL FLEET QUOTA FOR ALL SCOTIA-FUNDY PURSE SEINE VESSELS IN 4WX HERRING FISHERIES WILL BE 100,000 T FOR 1985 (OCTOBER 15, 1984 TO OCTOBER 14, 1985).

1. Vessel Quota

All purse seine vessels shall operate on an annual vessel quota as defined below:

Class A - 1.6% of purse seine quota, 1,600 tonnes
Class B - 2.7% of purse seine quota, 2,700 tonnes

These figures do not account for quota purchases. For those vessels with quota purchases, the 1985 vessel quotas are as follows:

LADY MELISSA	-	4,000
TOMMIE & ARNIE	-	3,200
LISA ANNE	-	3,200
SEAFOAM I	-	4,000
LEROY & BARRY I	-	4,000
MARGARET ELIZABETH	-	4,000
CANADA 100	-	4,000
CPRD	-	1,900
MATTUNA MARINER	-	4,000
MARIE LYNN ANITA	-	4,000

All vessels which have purchased quota shares must have circulating chilling systems prior to obtaining the 1985 purchased quota amount.

2. All vessel quotas will occur as a condition of licensing.

3. Participation

Any Scotia-Fundy purse seine vessel may participate in any or all of the following herring fisheries: 4W, 4X (fall), 4X (winter), 4X (summer). Restrictions will be limited to area quota and overall vessel quotas.

.../2

PART I (CONT'D)

I cont'd

4. Monitoring

Government/industry coordinated monitoring of the purse seine quota will occur through continual monitoring of all catches. The following procedures will be followed:

a) Industry/government monitoring of all nightly catches via verbal hail from each purse seine vessel captain identifying:

i) amount caught;
ii) port of unloading; and
iii) estimated time of unloading.

b) Written copy (DFO Landing Slip or Industry Delivery Note) of all verbal catch reports to be completed and forwarded to the industry/government central monitoring unit.

c) Accurate log records to be completed for each fishing trip and forwarded to DFO.

d) Purchase slip information to be completed by each purchaser and forwarded to DFO.

e) Fragmented (i.e., valid for specified periods) Condition of Licence Forms to be utilized in all purse seine fisheries within the Scotia-Fundy Region.

f) The fishery will be closed in the event of misreporting.

II. PURSE SEINE FISHERIES

(A) Sydney Bight (4Vn)

(1) The season for purse seine vessels shall run from November 7, 1984 to March 1, 1985.

(2) The quota will be 3,500 tonnes, to be taken by Gulf based purse seine vessels .

(3) The area of activity shall be north and west of a line drawn from Pt. Aconi in Cape Breton to the 3Pn Division intersect with the 4Vn line.

(4) The area east of the Pt. Aconi line in 4Vn shall not be fished by purse seine vessels.

PART I (CONT'D)

II cont'd

(B) Chedabucto Bay (4W)

(1) The season for purse seine vessels shall run from November 15, 1984 to March 1, 1985.

(2) The quota shall not exceed 16,000 tonnes to be taken by Scotia-Fundy vessels.

(3) The following closure line will be in effect until January 1, 1985, after which 40% of the overall quota may be harvested inside this line. Waters of Chedabucto Bay in 4W lying west of straight line extending from Cape Canso at 45°18' north latitude, 60°56' west longitude to Green Island at 45°29' north latitude, 60°54' west longitude.

(C) Bay of Fundy - Fall and Winter "Brit" Fishery

(1) The fall and winter Bay of Fundy purse seine fisheries will be combined into one fishery with the following provisions:

(a) The season will be October 16 to March 31 of the next year.

(b) A total of 9,000 t will be assigned in the following manner:

(i) up to 8,000 t to be caught in the October 15 - December 31 portion of the fishery.

(ii) of the amount captured in (i) above, 50% will be counted against the T.A.C. up to a maximum of 4,000 t;

(iii) the "brit" fishery will comprise the second portion of the fall and winter Bay of Fundy purse seine fishery with a January 1 - March 31 season;

(iv) the quota for the 1985 "brit" fishery will be 1,000 t;

(v) all catches will be deducted from individual vessel quotas for the 1985 season (50% of fall catch + 100% of the "brit" catch).

.../4

PART I CONT'D

II cont'd

(2) The fishery will be closed when:

- quotas are reached;
- seasonal closures are reached; or
- irregularities in quality, size or end-product use

(D) Bay of Fundy - Summer Fishery

(1) The season for purse seine vessels shall run from June 1, 1985 to October 14, 1985.

(2) The quota will be (100,000t - (X+Y+Z)), to be taken by Scotia-Fundy vessels.

X = 4W catch
Y = fall 4X catch (50%)
Z = 4X winter "brit" catch

(3) No separate bait allotment will be authorized in 1985.

(4) No purse seine fishery in Area 21 (June 1 - October 14) for 1985.

(5) The Trinity Ledge spawning Area (Schedule III, Item 5 - Atlantic Coast Herring Regulations) will be closed to purse seine activities August 25 to September 7 for 1985.

(6) A Georges Bank purse seine fishery is authorized under the following conditions:

(a) fishing to occur in the Canadian zone of 5Ze;

(b) a DFO observer must be present on all trips;

(c) 24 hours' notice must be given to DFO prior to departure; and

(d) failure to comply with parts, (a), (b) and (c) will result in any catch being assigned to that vessel's 4X quota.

(7) An 8,000t Over-the-Side Sales Program is to occur.

PART II

SCOTIA-FUNDY (4X) INSHORE HERRING GEAR TYPES

A. GENERAL

1. All catch information shall be provided to the Department for each catch.

2. All purchase slip information shall be provided for each purchase and shall include identification of amount purchased, fisherman and date of purchase.

3. All Nova Scotia inshore gear (weirs, traps and gill nets) previously under quota control will be assigned an allowance of anticipated catch for 1985.

4. No effort increases will occur in any inshore fishery.

5. All herring sold for bait will be recorded.

B. WEIR FISHERY

1. A 1,000t Over-the-Side Sales Program will occur.

C. HERRING SET NET FISHERY

1. After the season, all moorings must be removed from the water.

D. HERRING DRIFT NET FISHERY

1. Licences for drift nets are limited to those holding same for 1983.

2. An Over-the-Side Sales Program for 2,500t is to occur.

E. TRAP FISHERY

1. All mackerel traps in the 4X Area are limited to a 10% by-catch of herring up to a maximum of 100 t.

SUMMARY TABLE OF QUOTAS DIVISION FOR 1985

GEAR TYPE	AREA	SEASON	QUOTA	ALLOWANCE GUIDE
Purse Seine				
4X (Fall)	Bay of Fundy	October 15 - December 31/84	4,000*	
4X (Winter)	Bay of Fundy	January 1 - March 31/85	1,000	
4W	Chedabucto Bay	November 7/84 - March 1/85	16,000	
4X (Summer)	Bay of Fundy	June 1/85 - October 14/85	79,000	
			100,000	
Drift Gillnet	S.W. Nova	June 1/85 - October 15/85		
Set Gillnet	S.W. Nova	June 1/85 - October 15/85		25,000
N.S. Weir	Nova Scotia	June 1/85 - October 15/85		
Traps	Liverpool Bay	February 1/85 - May 1/85		
TOTAL QUOTA			100,000	
TOTAL PROJECTED CATCH (QUOTA + ALLOCATION)				125,000

* Quota represents 50% of T.A.C.